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(54) Method and apparatus for agitating and sampling a liquid specimen.

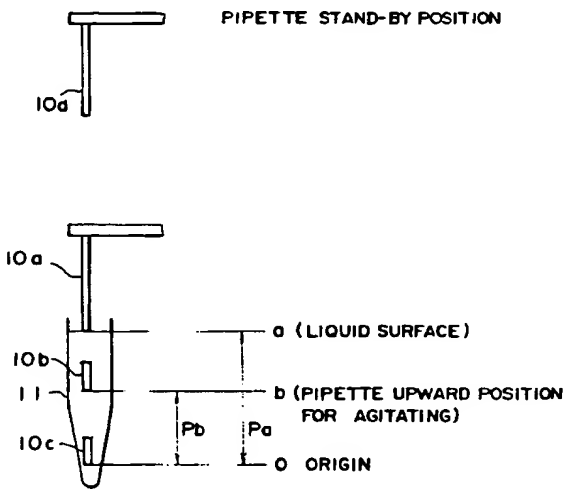
(57) Prior to using a pipette (10) to suck up a sample from a liquid specimen in a specimen container (11), the specimen is agitated by sucking up and discharging specimen whilst moving the pipette (10). Thus, sediment in the liquid specimen is evenly distributed before the sample is taken. Also, fragile solid components in the liquid specimen are not damaged.

Because the volume of the liquid specimen may vary, means (38, 40, 42) may be provided [see Figs. 6 and 7] which detect the surface (a) of the liquid specimen and adjust the range of movement (Pb) of the pipette (10) accordingly.

The apparatus may include an air bubble detecting device (55) having sensors (50, 52) in a specimen suction line (L). The sensors may be responsive to the difference in impedance between the liquid specimen and an air bubble.

The apparatus is particularly suited for use with a specimen of urine in a slender specimen container.

FIG.6



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The invention relates to a method and apparatus for agitating and sampling (aspirating) liquid specimens (samples) such as urine. The invention is, for example, useful in an automatic analyzer, in order to agitate and sample efficiently, without creating bubbles, a large volume of specimen contained in a slender container by aspirating and/or discharging the specimen at different positions.

When analyzing a specific solid component of a liquid specimen in an analyzer, the specimen must first be agitated to uniformly disperse the component, before the specimen is sampled. Otherwise, the intended component may remain at the bottom, and correct sampling is not effected.

Known methods of agitation include (1) inverting the container and (2) stirring the specimen in the container. In the case of method (1), the container must be tightly closed, and it cannot be applied to a container without a cap. In the case of method (2), it is not possible to agitate sufficiently a specimen in a slender container. Especially in the case of a container for urinary sediment, the bottom is narrow (see Figs. 4, 5), and it is difficult to uniformly disperse the components that have settled on the bottom.

Japanese Laid-open Patent Sho. 63-66466 discloses apparatus for sucking a mixed liquid from a reaction container and into a dispensing nozzle, and then discharging the liquid back into the reaction container in order to agitate it. In one embodiment, a reagent is discharged from a nozzle into a reaction container containing a specimen and mixes with the specimen. The nozzle front end is lowered to the bottom of the reaction container, and almost the whole volume of the mixed solution is sucked into the nozzle, and the whole volume is then discharged from the nozzle.

Apparatus is known for detecting bubbles when sucking a specimen. Japanese Laid-open Patent Hei. 2-61557 discloses apparatus comprising spaced apart electrodes in the liquid flow for discriminating between conductive liquid and nonconductive liquid, by applying an AC voltage between the electrodes and detecting the electrical resistance.

In Sho. 63-66466, aspirating from the bottom and discharging at the bottom does not create sufficient agitation. To compensate for this shortcoming, nearly the whole volume of the liquid is sucked up and discharged. If the liquid volume is small, it may be possible to suck and discharge the whole volume, but this is difficult if the liquid volume is large. To construct the apparatus of this publication, suction means with a large capacity and a large suction force is required, which also means that the aspiration and discharge steps are of long duration. Furthermore, the specimen (for example, urine containing blood corpuscles, epithethial cells, casts and other solid components) may be damaged because violent agitation may damage fragile components such as casts.

In either Sho. 63-66466 or Hei. 2-61557, nothing is mentioned about agitating the specimen by changing the position of a pipette when aspirating and discharging the specimen.

According to a first aspect of the present invention, there is provided a method of agitating and sampling a liquid specimen, comprising sucking specimen from a specimen container with a pipette, discharging the sucked specimen so as to agitate the specimen, and sampling the specimen with the pipette, wherein specimen suction and specimen discharge are carried out at different positions in the specimen container.

According to a second aspect of the present invention, there is provided apparatus for agitating and sampling a liquid specimen, comprising means for sucking specimen from a specimen container with a pipette, discharging the sucked specimen so as to agitate the specimen, and sampling the specimen with the pipette, wherein the apparatus further comprises driving means for varying the position of the pipette relative to the specimen container so that specimen suction and specimen discharge are carried out at different positions in the specimen container.

By moving the pipette, it is only necessary to suck up and discharge a small part of the specimen when agitating the sample. Thus, if fragile solid components are present in a specimen of large volume in a slender specimen container, they are less likely to be damaged than with the prior art methods. It is also a simple matter to arrange the movement of the pipette.

If necessary, the broadest aspect of the invention may terminate with the agitation of the specimen.

The invention will now be described by way of non-limiting embodiments with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic diagram of a first embodiment of apparatus for agitating and sampling a liquid specimen in accordance with the invention;

Fig. 2 is a time chart for explaining an example of the operation of the apparatus of the invention;

Fig. 3 is a time chart for explaining another example of the operation of the apparatus of the invention;

Fig. 4 is an explanatory diagram showing the position of the pipette in the specimen container when sucking liquid specimen;

Fig. 5 is an explanatory diagram showing the position of the pipette in the specimen container when discharging liquid specimen;

Fig. 6 is an explanatory diagram showing the movement of the pipette in a second embodiment of apparatus

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in accordance with the invention;

Fig. 7 is a block diagram of the apparatus of Fig. 6;

Fig. 8 is a schematic diagram of a third embodiment of apparatus for agitating and sucking a liquid specimen in accordance with the invention;

Fig. 9 is a partially cutaway sectional view of a suction pipette of the apparatus of Fig. 8;

Fig. 10 is a circuit diagram showing an example of a detecting circuit of the apparatus of Fig. 8;

Fig. 11 is a waveform diagram of a signal V1 appearing at a test point TP1 of the apparatus of Fig. 8;

Fig. 12 is a waveform diagram of a signal V2 appearing at a test point TP2 of the apparatus of Fig. 8; and

Fig. 13 is an explanatory diagram showing the motion of the specimen in the specimen suction line L of the apparatus of Fig. 8.

As shown in Fig. 1 - Fig. 7, the method for agitating and sucking liquid specimen of the invention relates to a method of sampling a specimen with a pipette 10 by sucking a specimen in a specimen container 11 by the pipette 10 for sucking specimen, discharging the sucked specimen, and agitating the specimen in the specimen container 11, in which

aspiration of specimen and discharge of specimen are conducted at different positions in the specimen container 11.

For example, either aspiration of specimen or discharge of specimen is done in the lower part of the specimen, and the other is done in the upper part of the specimen. Moreover, either one or both of aspiration of specimen and discharge of specimen may be done while moving the pipette 10, so that the agitation may be more efficient.

It is also possible to detect the liquid surface of the specimen, move the pipette 10 on the basis of the liquid surface detection information, and suck the specimen and discharge the specimen.

As shown in Fig. 1, the apparatus for agitating and sucking liquid specimen of the invention relates to an apparatus for sampling the specimen with a pipette 10 by sucking the specimen in the specimen container 11 by the pipette 10 for sucking specimen, discharging the sucked specimen, and agitating the specimen in the specimen container 11, in which

driving means 25 is disposed so as to vary the position of the pipette 10 when sucking the specimen and when discharging the specimen.

In thus composed apparatus of the invention, for example, the pipette 10 is lowered when sucking by the driving means 25, and is raised when discharging, or vice versa. Or the pipette 10 may be moved when sucking and discharging.

Furthermore, as shown in Fig. 7, the apparatus may also comprise liquid surface detecting means 38 for detecting the liquid surface of specimen, control circuit 40 for controlling the move of pipette 10 by receiving a signal from the liquid surface detecting means 38, and driving circuit 42 for driving the driving means 25 on the basis of the signal from the control circuit 40.

As shown in Fig. 8 - Fig. 13, the apparatus for agitating and sucking liquid specimen of the invention is also an apparatus for sampling specimen with a pipette 10 by sucking the specimen in the specimen container 11 by the pipette 10 for sucking specimen, discharging the sucked specimen, and agitating the specimen in the specimen container 11, which comprises:

driving means 25 for varying the position of the pipette 10 when sucking the specimen and when discharging the specimen, and a bubble detecting device 55 consisting of a sensor for producing a signal due to the difference in characteristics between liquid and air, disposed in the midst of the specimen suction line L, and a detecting circuit 53 for detecting the signal produced in the sensor.

More specifically, as shown in Fig. 8, the apparatus for sampling a specimen with a pipette 10 by sucking a specimen in a specimen container 11 with the pipette 10 for sucking specimen, discharging the sucked specimen, and agitating the specimen in the specimen container 11 further comprises:

driving means 25 for varying the position of the pipette 10 when sucking the specimen and when discharging the specimen, and

a bubble detecting device 55 composed of a set of electrodes 50, 52 disposed in the midst of the specimen suction line L, and a detecting circuit 53 for detecting the difference of electric impedance Ra of the two electrodes 50, 52.

In this apparatus for agitating and sucking liquid specimen, supposing the specimen suction amount when agitating the specimen to be Q1, the specimen suction amount when sucking the specimen to be Q2, and the volume of the pipette 10 from the front end (lower end) to the downward side electrode 50 to be Q3, it is desired to installed the downward side electrode 50 at a position satisfying the relation of $Q3 < (Q1 - Q2)$.

In this apparatus, by sucking the specimen in the specimen container 11 by the pipette 10 for sucking the specimen and discharging the sucked specimen, after agitating the specim n in the specimen container 11, when sampling the specimen with this pipette 10, suction of specimen and discharge of specimen are done at

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different positions in the specimen container 11.

For example, either one of specimen suction and specimen discharge is done in the lower part of the specimen, and the other in the upper part of the specimen. Moreover, either one or both of specimen suction and specimen discharge may be done while moving the pipette 10, so that the specimen may be agitated more efficiently.

Furthermore, by detecting the specimen liquid surface, the pipette 10 is moved on the basis of the liquid surface detection information, and suction of specimen and discharge of specimen are carried out.

By the driving means 25, the pipette 10 may be positioned downward when sucking, and upward when discharging, or vice versa. The pipette may be also moved when sucking and discharging. Besides, by the bubble detecting device 55, the bubble can be detected when agitating the specimen or when sucking the specimen, and therefore presence or absence of specimen may be detected, so that the reliability of the apparatus may be enhanced.

Embodiment 1

Fig. 1 is a schematic diagram of an apparatus for agitating and sucking liquid specimen showing an embodiment of the invention. Numeral 10 is a pipette for sucking liquid specimen, and suction means 12 is connected to this pipette 10. As the suction means 12, for example, a diaphragm type pump (hereinafter called diaphragm pump 12) is used. One compartment 14 of the diaphragm pump 12 partitioned by a diaphragm 13 is connected to the pipette 10, and the other compartment 16, to a valve 22 for changing over a positive pressure (higher than atmospheric pressure) source 18 and a negative pressure (lower than atmospheric pressure) source 20.

The pipette 10 is moved up and down by the driving means 25. This driving means 25 comprises, for example, an arm 24 nearly in the horizontal direction for holding the pipette 10, an endless belt 30 nearly in the vertical direction mounting this arm 24, pulleys 27, 28 disposed at the upper end and lower end of the endless belt 30, and a driving source 26 for driving the pulley 27 such as a stepping motor.

The endless belt 30 is threaded between the pulleys 27, 28, and when the pulley rotates normally or reversely, the arm 24 and pipette 10 move up and down in the specimen container 11, such as urinary sediment spitbox.

Fig. 2 is an example of timing chart for explaining the operation in the apparatus of the invention. Fig. 4 shows the state of suction of specimen, and Fig. 5 shows the state of discharge of specimen. The specimen container 11 is, for example, a urinary sediment spitbox for 10 ml.

Referring to Fig. 2, the agitation operation is described below.

(1) The driving source 26 operates to lower the pipette 10 to the state in Fig. 4.

(2) The valve 22 operates, and the other compartment 16 of the diaphragm pump 12 communicates with the negative pressure source 20, and the diaphragm pump 12 is set in suction mode, and the specimen is sucked, for example by 2 ml, from the pipette 10.

(3) The driving source 26 operates to raise the pipette 10 to the state in Fig. 5.

(4) The valve 22 returns to the initial state, and the other compartment 16 of the diaphragm pump 12 communicates with the positive pressure source 18, and the diaphragm pump 12 is set in discharge mode, and 2 ml of the specimen once sucked from the pipette 10 is discharged.

(5) The driving source 26 operates to lower the pipette 10 to the state in Fig. 4.

(6) Steps (2) through (6) are repeated.

(7) The uniformly agitated specimen is sucked, for example by 1 ml, by the pipette 10, and is presented for the process necessary for analysis.

Thus, by sucking the specimen in the lower part in the container and discharging in the upper part in the container, if the suction volume is small, the components settling in the lower part of a slender container are moved to the region small in the content of components, so that the concentration may be made uniform efficiently.

To the contrary, by sucking the specimen in the upper part in the container and discharging in the lower part in the container, similar effects are obtained. At this time, the specimen portion not containing the components is moved to the portion with high content of components, so that the concentration may be made uniform efficiently, too.

Furthermore, as shown in Fig. 3, by sucking and agitating the specimen while moving the pipette up and down, the liquid in the container is agitated more violently, and the time required for agitation may be shortened.

After the specimen agitation and suction steps, the cleaning step begins. The pipette 10 moves to the cleaning tank (not shown). One compartment 14 of the diaphragm pump 12 is connected with a cleaning solution tank 36 through a valve 32 and the positive pressure source 18 through a valve 34. As the valve 32 opens, the

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cleaning solution is supplied from the cleaning solution tank 36, and the specimen suction line including the pump 12 and pipette 10 is washed. As the valve 32 is closed and valve 34 is opened, the cleaning solution is removed by air, thus finishing the cleaning step.

Embodiment 2

The embodiment is, as shown in Fig. 6 and Fig. 7, intended to agitate more effectively by adding the liquid surface detecting function.

The control of the agitation operation by liquid surface detection is described below. In the analyzer, the volume of the specimen entering the specimen container 11 is not always constant (the height of the liquid surface is not always constant). When the sample volume is small, if the specimen is sucked, discharged and agitated while keeping constant the moving stroke of the pipette, bubbling of specimen, suction of bubbles when sampling, and splash of specimen may take place.

To solve such problems, by detecting the liquid surface, the moving distance of the pipette when agitating is determined on the basis of the detected information. Any known means may be used for detecting the liquid surface. The method of determining the moving distance of the pipette from the position information of liquid surface obtained by the liquid surface detecting means is practically described below while referring to fig. 6.

First of all, the origin O (pipette lowering position) is determined. It is set by a limit switch. The height from the origin O to the pipette 10 corresponds to the number of pulses of the stepping motor. The number of pulses pb corresponding to the pipette moving distance when agitating is determined as follows from the liquid level information of the liquid surface. Supposing the number of pulses of moving from detection of liquid level till origin O to be Pa, it follows that

$$Pb = K1 * Pa \text{ or } Pb = Pa - K2$$

where K1, K2 are constant, which may be desired values.

In this way by varying the moving distance of the pipette 10 depending on the difference of the specimen volume (height of liquid surface), the above problem can be solved, and the specimen may be agitated smoothly if the sample volume in the specimen container 11 is small or large. In Fig. 6, the letter b denotes the ascending position of the pipette 10 when agitating, 10a is the pipette detecting the liquid level a, 10c is the pipette located at the origin O, and 10d is the pipette in standby position.

More specifically, as shown in Fig. 7, the specimen liquid surface is detected by the liquid surface detecting means 38, and the detection signal is entered in the control circuit 40. The signal of the control circuit 40 is then fed into the driving circuit 42, and the driving means 25 is driven to move the pipette 10.

The apparatus in Embodiment 1 and Embodiment 2 is composed as described above, and brings about the following effects.

(1) The specimen is agitated by sucking and discharging at different positions, and therefore even a large volume of specimen contained in a slender container can be agitated efficiently and smoothly without bubbling.

(2) The agitation is more efficient when sucking and discharging while moving the pipette.

(3) The structure is simple because the same pipette is used for agitating by sucking and discharging and for sampling.

(4) If the specimen container differs in length (height) or the specimen volume varies, it is flexibly handled by varying the moving distance of the pipette.

Embodiment 3

Fig. 8 is a schematic diagram showing a further different embodiment of the apparatus for agitating and sucking liquid specimen of the invention. Same as in Fig. 1, numeral 10 is a pipette for sucking liquid specimen, and suction means 12 is connected to the pipette 10. As the suction means 10, for example, a diaphragm type pump (hereinafter called diaphragm pump 12) is used. One compartment 14 of the diaphragm pump 12 partitioned by a diaphragm 13 is connected to the pipette 10, and the other compartment 16 is connected to a valve 22 for changing over the positive pressure (higher than atmospheric pressure) source 18 arid negative pressure (lower than atmospheric pressure) source 20.

The pipette 10 is moved up and down by driving means 25. The driving means 25 comprises, for example, an arm 24 nearly in the horizontal direction for holding the pipette 10, and endless belt 30 nearly in the vertical direction mounting the arm 24 thereon, pulleys 27, 28 disposed at the upper end and lower end of the endless belt 30, and a driving source 26, such as stepping motor, for driving the pulley 27.

The endless belt 30 is threaded between the pulleys 27, 28, and as the pulley rotates normally and reversely, the arm 24 and pipette 10 move up and down in the specimen container, for example, a urinary sedi-

ment spitbox.

Besides, as shown in Fig. 6 and Fig. 7, by adding the liquid surface detecting function, a more effective agitation may be possible.

That is, the apparatus may further comprise liquid surface detecting means 38 for detecting the liquid surface of specimen, a control circuit 40 for controlling the move of the pipette 10 by receiving a signal from the liquid surface detecting means 38, and a driving circuit 42 for driving the driving means 25 on the basis of the signal from the control circuit 40.

In addition to the apparatus described so far, the apparatus of the embodiment also comprises a bubble detecting device 55 as shown in Fig. 8. The bubble detecting device 55 is composed of, for example, electrodes 50, 52, wiring cords 76, 78, and a detecting circuit 53.

In the midst of the specimen suction line L from the front end of the suction pipette 10 till the suction means 12, a set of corrosion-resistant conductive materials, for example, electrodes 50, 52 made of stainless steel are disposed at a specific distance in the liquid flow direction. The electrodes 50, 52 are disposed so as to contact directly with the specimen (urine, in this embodiment) flowing in the specimen suction line L. The electrodes 50, 52 are connected to a detecting circuit 53 through wiring cords 76, 78, respectively. In the detecting circuit 53, on the basis of the difference of the electric resistance Ra between the electrodes 50, 52, it is detected whether the urine specimen is present between the electrodes 50, 52 (the resistance Ra is small), or air is present (Ra is large). The urine is a conductive liquid. The conductivity varies significantly in each specimen, but it may be distinguished from air. It is also possible to discriminate if the specimen suction line L is made of an opaque material.

The detecting circuit 53 comprises an oscillator 54 for continuously issuing pulse signals, an impedanc (resistance) Rc connected to the output of the oscillator 54, a wave detecting circuit 56 connected to the resistance Rc, and a comparator 58 connected to the wave detecting circuit 56, and the electrodes 50, 52 are connected to the ground and resistance Rc through wiring cords 76, 78 so as to detect the output of the oscillator 54 by dividing in resistance between the resistance Rc and resistance Ra between electrodes. Numeral 59 is a voltage source for supplying a reference (standard) voltage for the purpose of comparison. TP1 is a test point for observing the pulse signal V1 varying in wave crest value depending on the difference of the resistance Ra between electrodes, and TP2 is a test point for observing the DC voltage V2 varying in level depending on the difference of the resistance Ra between electrodes.

Fig. 9 is a side sectional view of the suction pipette 10. Numerals 72, 74 are, for example, fluororesin tubes (Teflon tubes) of 2 mm in inside diameter and 3 mm in outside diameter. The front end (lower end) of the tube 72 is tapered. The tube 74 is spiral so as not to disturb the movement of the pipette 10. The tubes 72, 74 are coupled by means of stainless steel electrodes 50, 52 screwed to both ends of a relay tool 75, and fixing pieces 68, 70 screwed to the electrodes 50, 52. The coupling part of the tubes 72, 74 is in flange form, and by pinching the flange with the electrodes and fixing pieces, the airtightness is maintained, and the tubes are coupled together. The relay tool 75, and the electrodes 50, 52 possess internal passages, and the electrodes 50, 52 directly contact with the specimen in the internal passages.

The distance from the front end (lower end) of the tube 72 till the electrodes 50, 52 is, for example, 110 mm and 120 mm. Therefore, the volume from the front end of the tube 72 to the electrodes 50, 52 is respectively 0.35 ml, 0,38 ml. Wiring cords 76, 78 are connected to the electrodes 50, 52.

Fig. 10 is a practical circuit diagram of the detecting circuit 53. A capacitor C3 is connected in series to the resistance Rc, and resistance Tb, parallel to the resistance Ra between electrodes. This is intended to detect bubbles smoothly. The values of these elements may be adjusted to the optimum values so that the difference may be great, between when the specimen is present in the electrode part and when not present, by observing the degree of change of the pulse signal V1 appearing at the test point TP1. For example, the resistances Rc, Rb and capacitor C3 are 33 kohms, 220 kohms, and 0.047 μF, respectively. The resistance R1 and capacitor C2 are, for example, 100 kohms, 0.015 μF, respectively. M1 is a Schmitt trigger NAND gate of CMOS.

Fig. 11 and Fig. 12 denote the waveforms of signals V1, V2 appearing at test points TP1, TP2. The oscillation frequency of the pulse signal is, for example, 2.0 kHz. Numeral 60 is a signal V1 in the presence of specimen, and 62 is a signal V1 in the absence of specimen (in the case of air). Numeral 64 denotes a waveform of a signal V2 with specimen, and 66 is of a signal V2 without specimen (in the case of air). The signal V1 detected by the detecting circuit 56 is compared with a specific voltage V3 in a comparison circuit 58, and is changed into a binary value depending on the presence or absence of specimen.

This is to explain, by referring to a practical example, how the bubble det cting device 55 operates in the apparatus for agitating and sucking liquid specimen.

Fig. 13 (a) to (d) show the motion of the sp cim n in the specimen suction line L. The specification of the apparatus for agitating and sucking liquid specimen may be as follows.

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Suction volume when agitating specimen	Q1 (2 ml)
Suction volume when sucking specimen (sampling volume)	Q2 (1 ml)
Volume from front end (lower end) of pipette 10 to lower side electrode 50	Q3 (0.35 ml)

Just before starting agitation, the inside of the specimen suction line L must be empty as shown in Fig. 13 (a). This state is first detected by the bubble detecting device 55. Unless empty, the liquid mixes into the specimen container when agitating the specimen.

In the process of specimen agitation, when the specimen is sucked in Q1, the state becomes as indicated by shaded area in fig. 13 (b). At this time, it is also detected that the specimen is present between the electrodes 50, 52, and it is known that the specimen for agitation is sucked correctly. If the sample volume in the specimen container is small, once after becoming sample state, it is changed to a bubble state (short sample) as shown in Fig. 13 (c). To be in bubble state at the time of specimen agitation means that the volume of air portion is more than Q3, and the specimen volume Q that can be sucked is less than (Q1 - Q3). In other words, $Q < (Q1 - Q3)$. For correct sampling, this specimen volume Q must be larger than the specimen suction volume Q2. It is required therefore that $Q2 < Q$, hence $Q2 < (Q1 - Q3)$. If kept at $Q3 < (Q1 - Q2)$, the condition is satisfied. Incidentally, if the specimen suction line L is clogged, the specimen does not reach up to the electrode 50 part, but the bubble state remains as shown in Fig. 13 (d).

The positions for installing the electrodes 50, 52 are not particularly limited, as far as the specimen suction may be monitored, but it is advantageous when set as specified above.

In this embodiment, the sensor for producing the difference due to the difference in the characteristics of liquid and air is composed of two electrodes, but the bubbles may be also detected, for example, by electric impedance, by ultrasonic wave or light (transmission light, reflection light).

The apparatus in Embodiment 3, being thus composed, brings about the following effects.

(1) The specimen is agitated by varying the pipette position by the driving means and sucking and discharging the specimen at different positions, and therefore the sample, if a large volume is contained in a slender container, may be efficiently and smoothly agitated without bubbling. In this case, the agitation is more efficient if sucking and discharging while moving the pipette.

(2) The constitution is simple because the same pipette is used for agitating by sucking and discharging and for sampling. Besides, the specimen container differing in length (height) or the specimen large or small in volume may be easily handled alike only by varying the moving distance of the pipette.

(3) Aside from the driving means, the bubble detecting device is provided, and therefore when agitating specimen or sucking specimen, the presence or absence of specimen may be detected (detection of air bubbles), so that an apparatus for agitating and sucking liquid specimen of higher reliability may be realized.

Having described preferred embodiments of the invention with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope of the invention.

Claims

1. A method of agitating and sampling a liquid specimen, comprising sucking specimen from a specimen container (11) with a pipette (10), discharging the sucked specimen so as to agitate the specimen, and sampling the specimen with the pipette (10),
   wherein specimen suction and specimen discharge are carried out at different positions in the specimen container (11).

2. A method according to claim 1, wherein either one of specimen suction and specimen discharge is carried out in the lower part of the specimen in the specimen container (11), and the other one of specimen suction and specimen discharge is carried out in the upper part of the specimen in the specimen container (11).

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3. A method according to claim 1, wherein at least one of specimen suction and specimen discharge is carried out while moving the pipette (10) relative to the specimen container (11).

4. A method according to any one of claims 1 to 3, wherein the specimen liquid surface is detected and the pipette (10) is moved on the basis of the detected liquid surface, so as to keep the pipette (10) projecting below the specimen liquid surface during specimen suction and specimen discharge.

5. Apparatus for agitating and sampling a liquid specimen, comprising means (12) for sucking specimen from a specimen container (11) with a pipette (10), discharging the sucked specimen so as to agitate the specimen, and sampling the specimen with the pipette (10),
wherein the apparatus further comprises driving means (25) for varying the position of the pipette (10) relative to the specimen container (11) so that specimen suction and specimen discharge are carried out at different positions in the specimen container (11).

6. Apparatus according to claim 5, further comprising:
liquid surface detection means (38) for detecting the liquid surface of the specimen,
control circuit means (40) for controlling the movement of the pipette (10) in response to a signal received from the liquid surface detection means (38), and
driving circuit means (42) for driving the driving means (25) on the basis of a signal received from the control circuit means (40).

7. Apparatus according to claim 5 or 6, further comprising:
air bubble detection means (55) having a sensor (50, 52) responsive to liquid and air in a specimen suction line (L), and air bubble detection circuit means (53) for determining that there is an air bubble in the specimen suction line (L) by processing the response of the sensor (50, 52).

8. Apparatus according to claim 7, wherein the sensor (50, 52) comprises a pair of electrodes (50, 52) disposed in the specimen suction line (L), and the air bubble detection circuit means (53) is responsive to changes in the electrical impedance (Ra) between the electrodes (50, 52).

9. Apparatus according to claim 8, wherein the electrode (50) closer to the pipette (10) is disposed at a position satisfying the relationship $Q3 < (Q1 - Q2)$, where the specimen suction volume when agitating the specimen is Q1, the specimen suction volume when sampling the specimen is Q2, and the volume from the open end of the pipette (10) to the closer electrode (50) is Q3.

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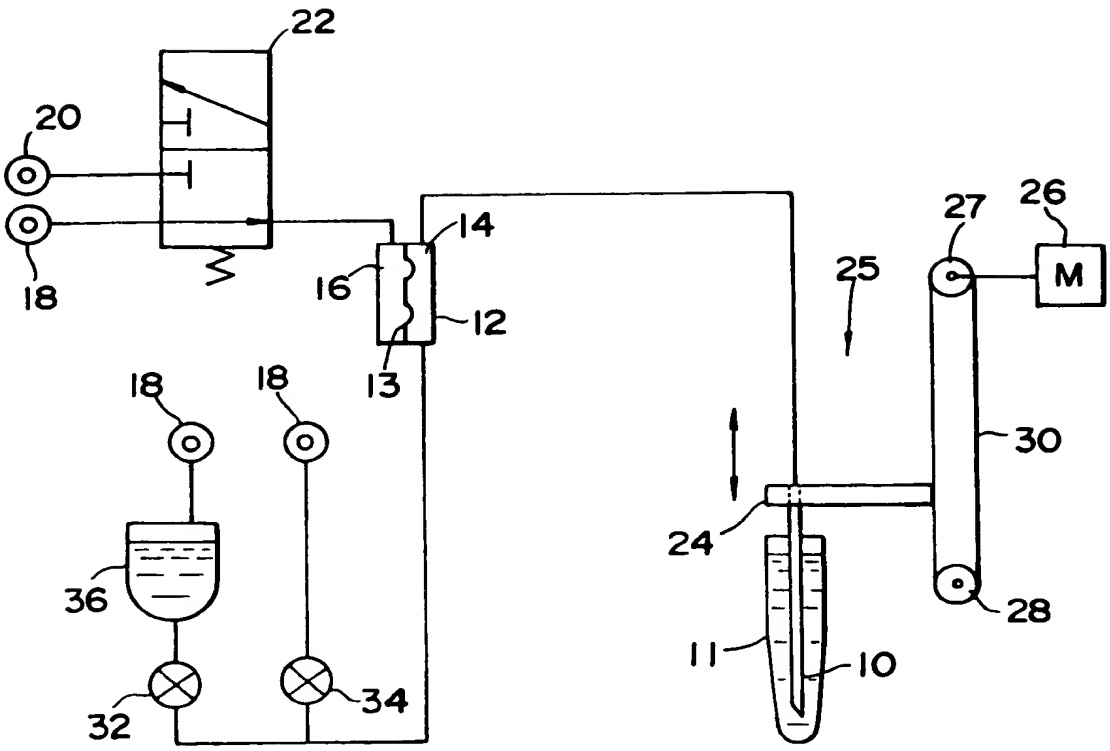
FIG.1



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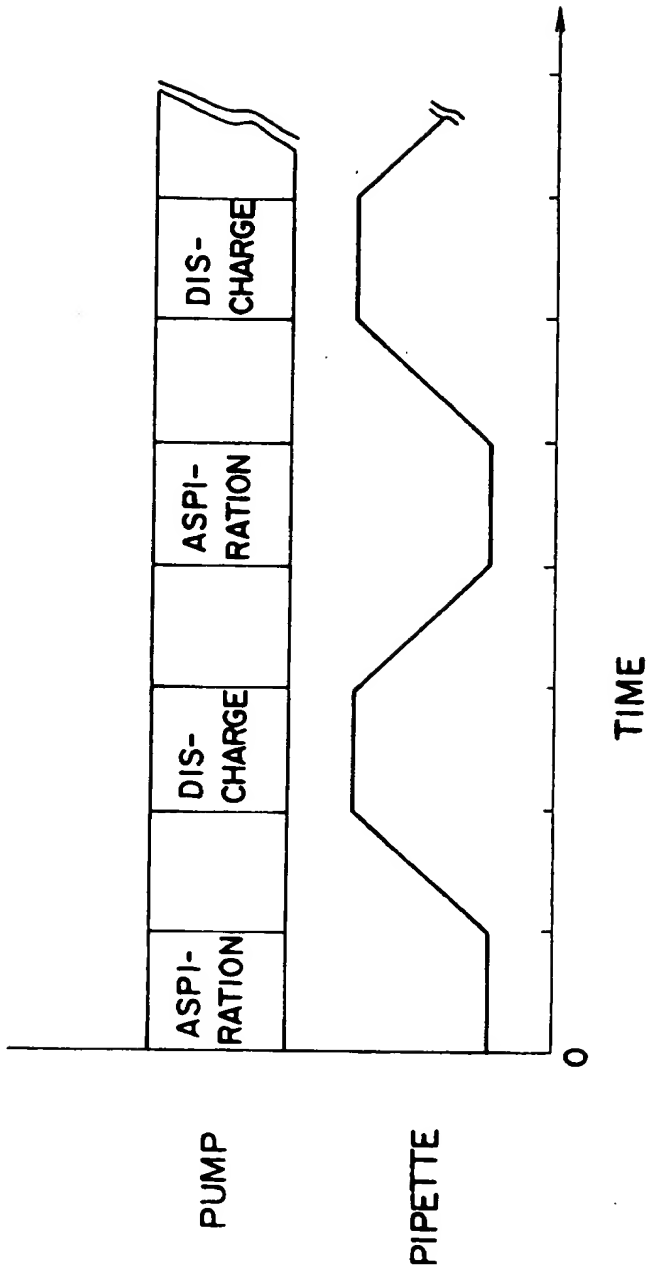

FIG.2

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FIG.3

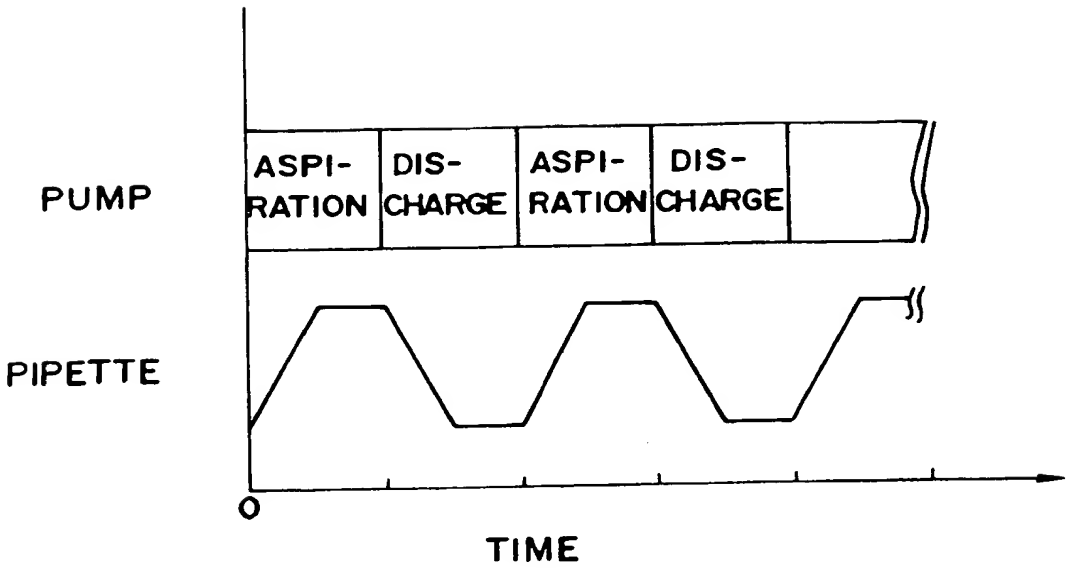

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FIG.4

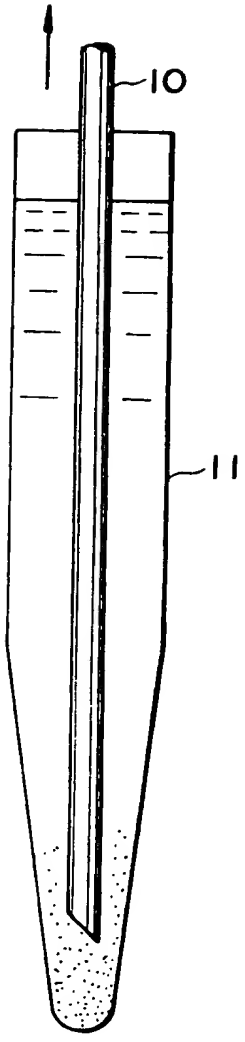

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FIG.5

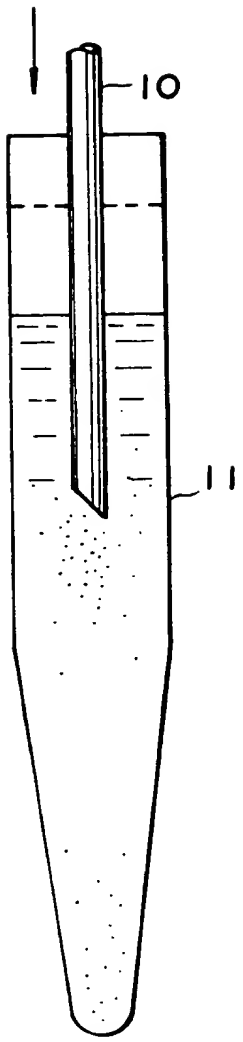

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FIG. 6

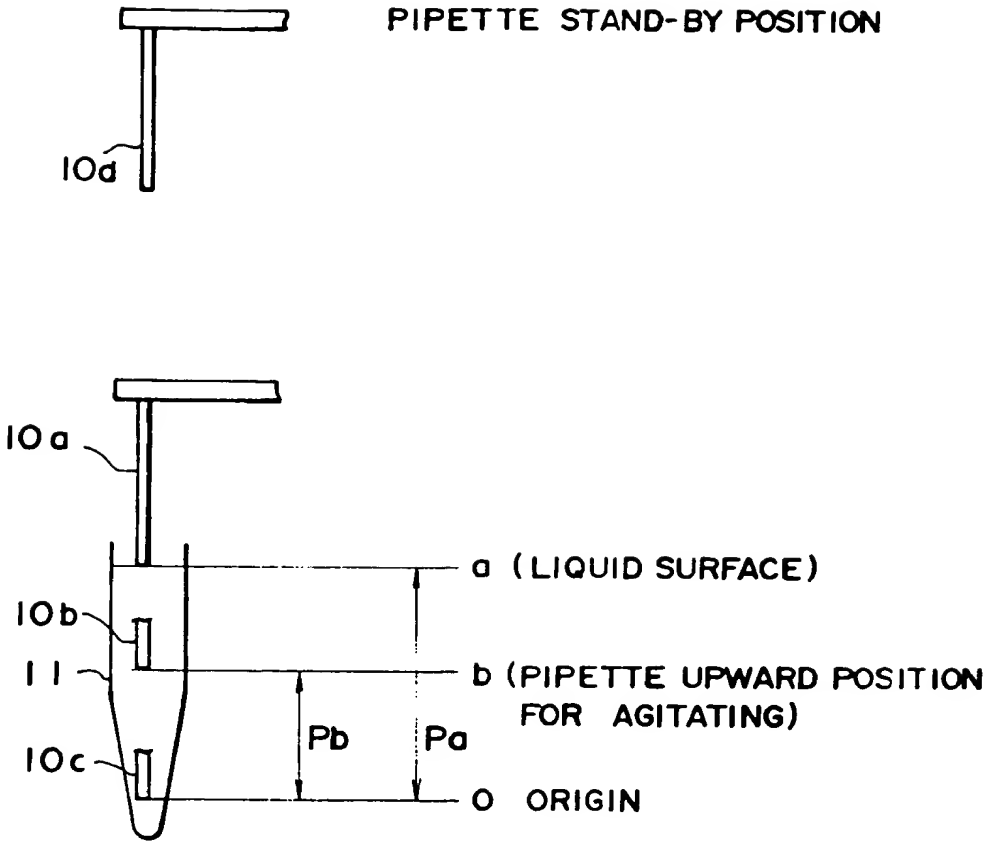

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FIG.7

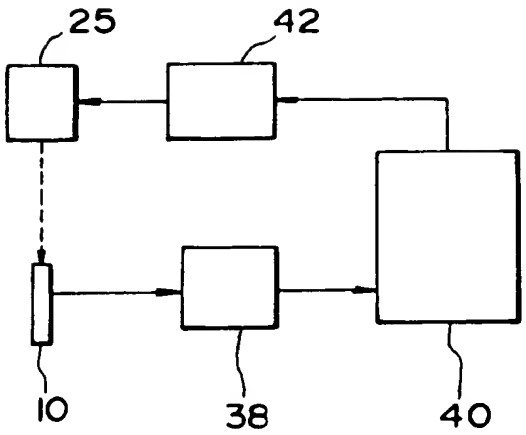

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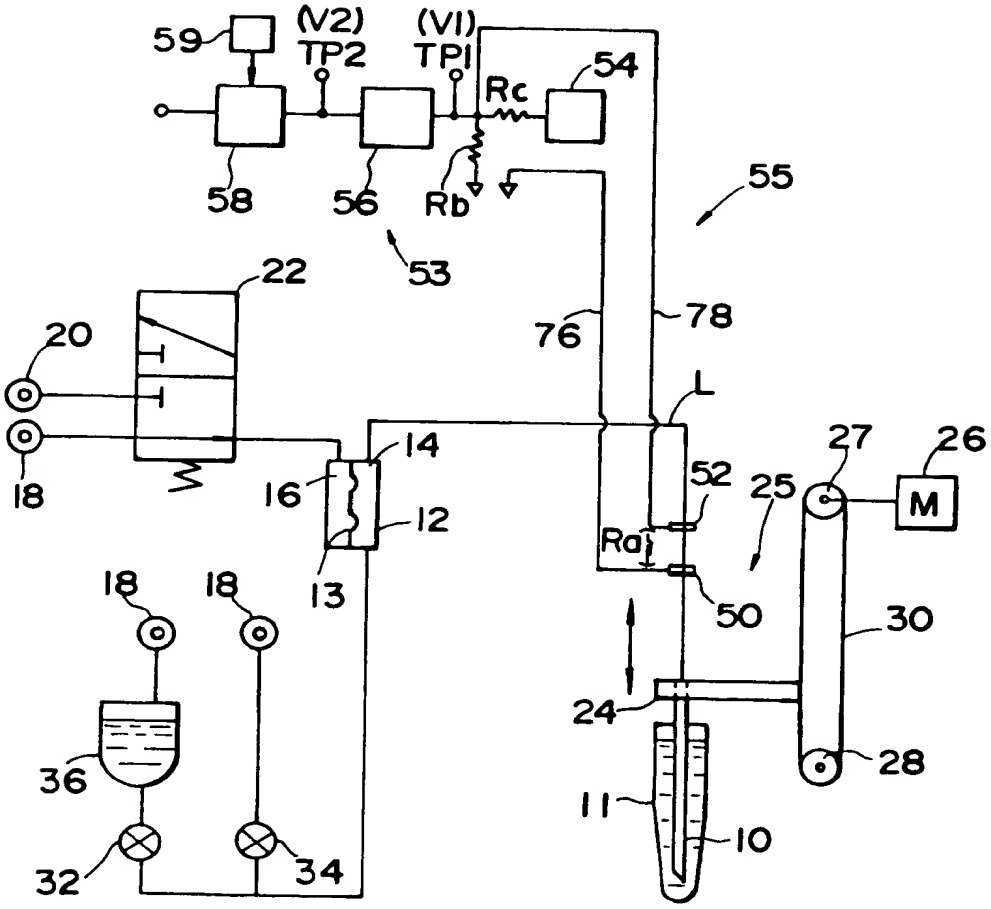
FIG.8


59
(V2)
TP2
(VI)
TPI
Rc
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58
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Rb
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L
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14
16
12
13
52
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26
25
M
Ra
18
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50
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32
34

FIG. 9

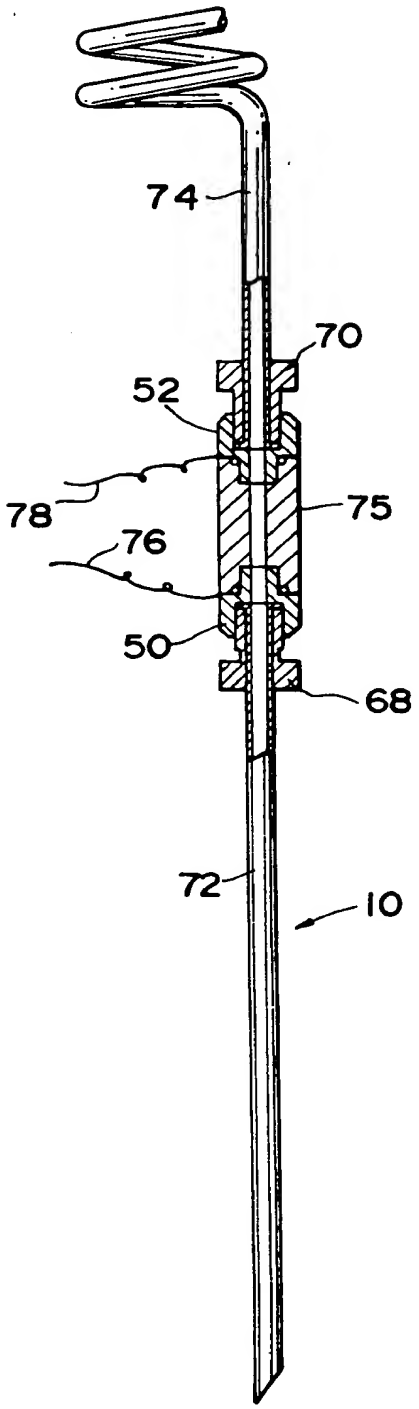

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FIG.10

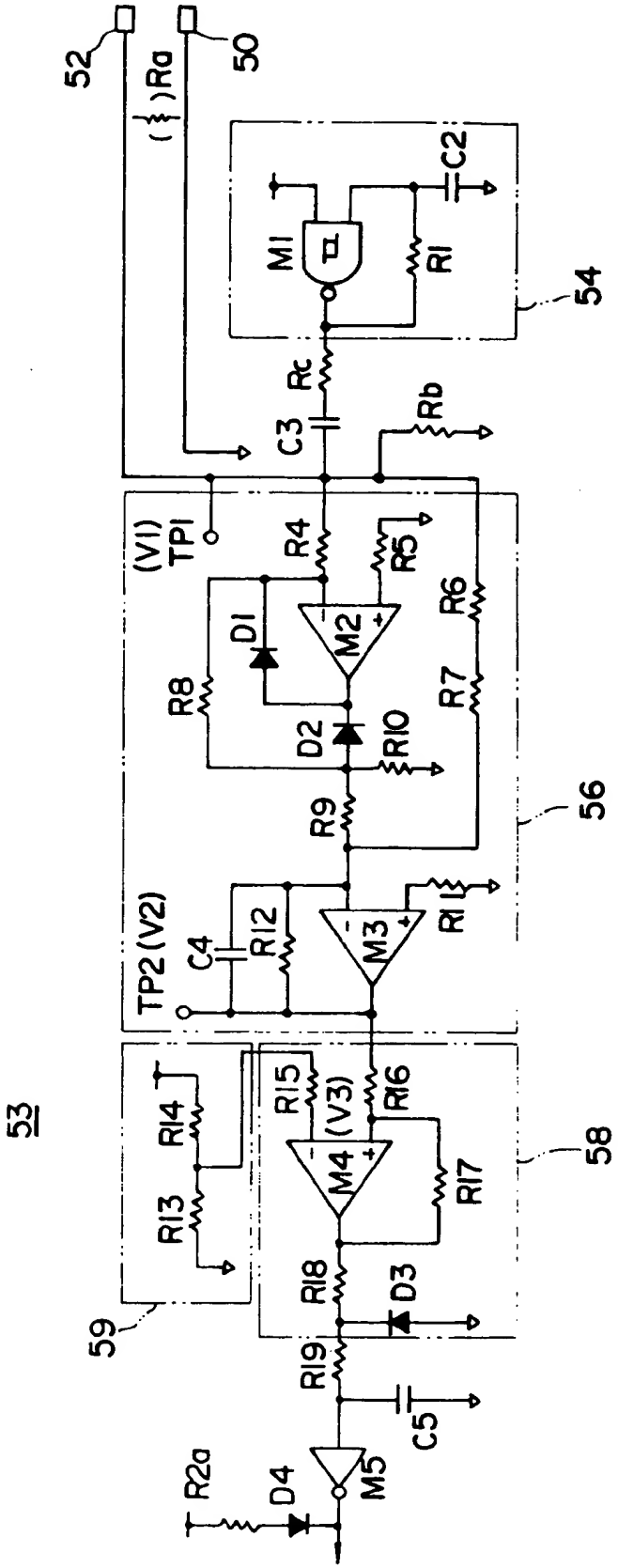

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FIG.11

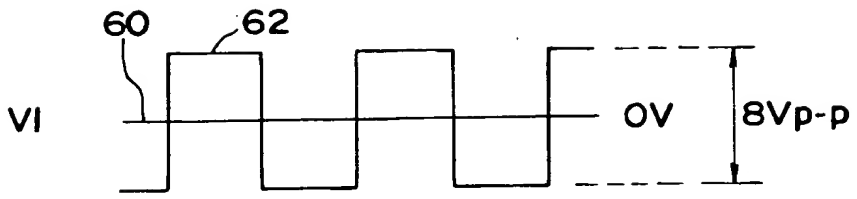

FIG.12

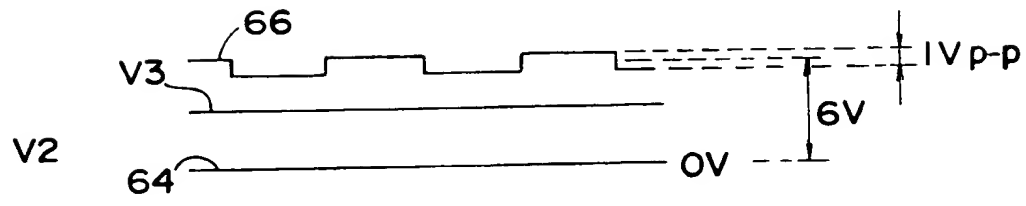

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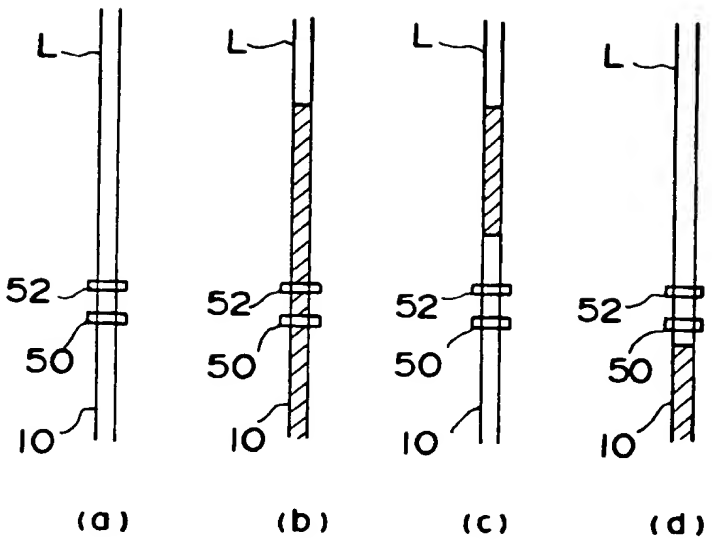
FIG.13



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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 92 30 7246

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X Y	EP-A-0 411 620 (HITACHI) * page 3, line 50 - page 4, line 2 * * page 5, line 39 - page 6, line 7 * * page 7, line 14 - line 29 * * page 11, line 35 - page 12, line 17 * * figure 8 *	1-6 7,8	G01N1/00 G01N35/06 B01L3/02
Y A D	DE-C-3 927 718 (HITACHI) * column 7, line 46 - column 8, line 10 * * figure 6 * & JP-A-02 061 557 (...)	7,8 9	
A	EP-A-0 210 014 (CETUS CORPORATION) * page 32, line 1 - page 39, line 27 * * figures 4,5 *	1-6	
A	DE-U-9 100 548 (G. KAMPFRATH ET AL) * claim 1; figure 2 *	7-9	
P,X	WO-A-9 118 273 (SCIENTIFIC IMAGING INSTRUMENTS) * page 11, line 18 - page 13, line 2 * * figure 6 *	1,2,4-6	TECHNICAL FIELDS SEARCHED (Int. Cl.5) G01N B01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	12 NOVEMBER 1992	JOHNSON K.

CATEGORY OF CITED DOCUMENTS

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